Canada Alberta

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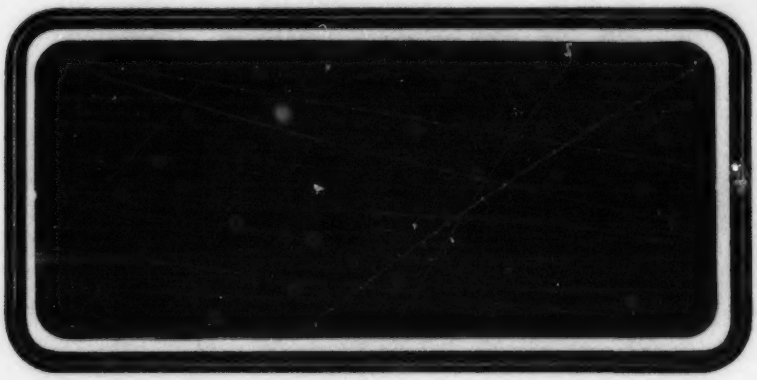

Canada Alberta

The Canada-Alberta Forest Resource Development Agreement is a subsidiary agreement of the Canada-Alberta Economic and Regional Development Agreement, which provides coordination and cooperation between the governments of Alberta and Canada in areas of Alberta's economic development.

The Canada-Alberta Forest Resource Development Agreement is funded equally by the governments of Canada and Alberta, from April 1, 1984, to March 31, 1989.

Its primary objectives are to ensure the long-term availability of timber supplies; to optimize timber uses; and to contribute to the growth and diversification of Alberta's economy.

The Agreement comprises three programs: Reforestation; Applied research, technology transfer and opportunity identification; and Public information, evaluation and administration. These programs are managed by a joint Directorate and are implemented by Forestry Canada and the Alberta Forest Service.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est auxiliaire à l'Entente Canada-Alberta sur le développement économique et régional, qui vise à assurer la coordination et la coopération des deux gouvernements relativement au développement économique de l'Alberta.

L'Entente Canada-Alberta sur la mise en valeur des ressources forestières est financée à parts égales par les gouvernements du Canada et de l'Alberta, et a cours du 1er avril 1984 au 31 mars 1989.

Ses objectifs principaux sont assurer la disponibilité à long terme de réserves de bois; optimiser leur utilisation; et contribuer à la croissance et la diversification de l'économie de la province.

L'Entente comprend trois programmes: Reboisement; Recherche appliquée, transferts de connaissances techniques et relevé des occasions; et Information, évaluation et administration. Ces programmes sont gérés par un Bureau de direction conjoint, et mis en oeuvre par Forêts Canada et le Service forestier de l'Alberta.

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STATUS OF BALSAM (BLACK) POPLAR UTILIZATION IN WAFERBOARD/OSB PRODUCTION

(Summary Report)

F. Pfaff
Forintek Canada Corp.[1]

1988

This is a joint publication of Forestry Canada and the Alberta Forest Service pursuant to the Canada-Alberta Forest Resource Development Agreement

Ottawa, Ontario[1]

Project #

DISCLAIMER

The study on which this report is based was funded in part under the Canada/Alberta Forest Resource Development Agreement.

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Catalogue No.: FO 42-91/50-1988E
ISBN: 0-662-16344-3

Additional copies for this publication are available at no charge from:

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PREFACE

By the request of the industry and government, a Task Force was set up to review the utilization potential of black poplar (Populus balsamifera L.) for the production of oriented strandboard and waferboard. The membership of the Task Force is given below. They have met on a few occasions and their work is summarized in this report.

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10.	Dr. Jean Poliquin	Universite-Laval Quebec City, Quebec
11.	Jack Shields	Forintek Canada Corp. Ottawa, Ontario
12.	Ted Szabo	Government of Alberta Edmonton, Alberta

1.0 BACKGROUND

In May of 1987 a meeting of Forintek's western Research Program Committee brought together several people that had a common interest in finding a means of utilizing balsam poplar in the production of waferboard and OSB. This species is commonly known as black poplar in western Canada.

Past experience with balsam poplar in mill trials had not been favourable because the simple mixing of balsam poplar with aspen produced boards of lower quality.

A concerted effort was needed to define the difficulties and resolve the problems. In August, Forintek hosted a meeting with the objective of establishing a task force on balsam (black) poplar. In attendance were representatives of waferboard/OSB producers, Government of Alberta, the Alberta Research Council, the University of Toronto and Forintek. The significant results of this meeting were to initiate a progressive action plan, commencing with the assimilation of all relevant information and the preparation status papers for presentation at future meetings.

On November 1, members of the task force and invited guests met to review the information and to discuss problems and opportunities with respect to the greater utilization of balsam poplar in waferboard/OSB.

This report summarizes the balsam poplar 'situation' and the opinions and recommendations forwarded by the task force as of November 1, 1987. Appendix I compares the properties of experimental aspen and balsam poplar waferboards produced by various investigators. Appendix II lists the references made available to the task force.

2.0 SPECIES CHARACTERISTICS

2.1 Balsam Poplar (Populus balsamifera L.)

Other common names
- black poplar
- balm poplar
- balm-of-Gilead
- tacamahac
- rough-barked poplar

Distribution range - Coast-to-coast (Figure 1)

Forest types - In pure stands but more often in mixture with other species (aspen, birch, willow, spruce and balsam fir)

Mature size - Typically 18-24 m (60-80 ft.) high and 30-60 cm (12-24 in.) diameter. Larger on ideal sites (rich, moist soils).

- Branch-free to 2/3 of height in closed stands.

Volume - Nationally about 15 percent of total poplar volume. Regionally from 0 to 30 percent.

2.2 Balsam Poplar and Trembling Aspen Differences

Poplars by nature are highly variable in properties and characteristics. The following comparisons indicate typical characteristic that may be representative over a broad range.

	Balsam Poplar	Trembling Aspen
Specific gravity	0.30 - 0.38	Similar variation but generally 0.02 higher
Moisture content over long term (%)	110 - 150	Similar variation but generally lower (90-130)
Fiber length (mm)	0.90 - 1.10	Generally longer (to 1.40) and less gelatinous
Fiber diameter (μ)	26 - 30	Generally smaller (16-25)
Acidity (pH)	Western data heart 7 - 9 sap 5 - 6	Eastern data heart lower sap similar
Decay or cull (%)	3 - 10	Somewhat more for same age
Mature bark volume (%)	10 - 20	Typically lower

3.0 LABORATORY INVESTIGATIONS

3.1 Experimental Data

The following comments and conclusions are drawn from eight reports in which test results are presented for waferboard/OSB panels. Tabulated comparisons are given in Appendix I. As far as can be determined, these results are for uniformly dried wafers and do not reflect problems that may be encountered in mills as a result of the different moisture content and drying characteristics of aspen and balsam poplar.

Reports referenced (as per Appendix II):

1. Waferboards made from balsam poplar and trembling aspen (Hsu)

2. Balsam poplar as a raw material for waferboard (Panning and Gertjejansen)

3. A comparative study of the physical and mechanical properties of trembling aspen waferboard and mixed trembling aspen - balsam poplar waferboard (Badger)

4. Black poplar and aspen waferboard and OSB properties (A.R.C.)

5. Aspen vs. black poplar differences - FPLE 99 (A.R.C.)

6. Ring flaked maxi-chips: the manufacture, testing and evaluation of composite board made from Alberta woods (Morrison-Knudsen)

7. Laboratory report for September 1981 (Borden Chemical)

8. Evaluation of black poplar in waferboard (Reichhold Chemicals)

3.1.1 Internal bond (IB)

The addition of balsam poplar reduces IB strength. The reductions can be considerable and tend to increase as the amount of balsam poplar increases. The data would suggest that any aspen boards that are marginally above the CAN-0437.0 limit would fail IB if a significant quantity of balsam poplar is included in the furnish (i.e. 10-15%).

3.1.2 Modulus of rupture (MOR)

The data indicates that MOR will decrease as the quantity of balsam poplar increases when press cycles are at or under 5 minutes and the resin content is in the range of 2 to 2.5 percent (7/16 powdered phenolic board). This trend, however, was erratic, with both marginal and large strength reductions. At 3 percent resin content and/or longer press cycles, it appears that boards with balsam poplar are as good as 100 percent aspen boards.

3.1.3 Bond durability (% MOR retention)

Bond durability is essentially similar for aspen and balsam poplar. In other words, the lower dry MOR's of balsam poplar and mixed species boards should not be disproportionately affected by the durability tests.

3.1.4 Modulus of elasticity (MOE)

No consistent trend is expected. Boards of 100 percent balsam poplar may have higher values as well as lower values compared to aspen and mixed species boards.

3.1.5 Thickness swelling (TS)

Average TS is greater for balsam poplar and mixed species boards, although some boards with balsam poplar were only marginally inferior to 100 percent aspen boards.

3.1.6 Linear expansion (LS)

Linear expansion is not affected by the addition of balsam poplar to the furnish.

3.2. Implications

Most studies show that certain board properties would be adversely and significantly affected by the addition of balsam poplar to the furnish - specifically;

Internal bond
Modulus of rupture
Thickness swelling

Nevertheless, on a laboratory basis it was possible to obtain values of IB, MOR and TS that exceeded CAN-0437.0 requirements with boards containing a large quantity of balsam poplar. Twelve of sixteen balsam poplar or mixed boards exceeded minimum IB. All but one exceeded minimum MOR, and several complied with minimum TS. On the other hand, optimum properties in excess of minimum requirement are clearly jeopardized by balsam poplar and of legitimate concern to a quality conscious industry. This is particularly significant in view of the understanding that commercial boards typically have lower property values than those produced under laboratory conditions.

4.0 INDUSTRIAL EXPERIENCE/CONCERNS

A need to segregate and process the species separately is anticipated because of the unfavourable results obtained with 'ad-hoc' mixtures of balsam poplar and aspen in mill trials. Without control of the mixture the board properties could not be assured due to difficulties with moisture control, species/board density and wafer quality.

The higher moisture content and thicker bark of balsam poplar results in increased thawing time, and the shorter gelatinous fibres plug the waferizer knives (wrap around cutting edges). This reduces cutting effectiveness and wafer quality - more fines, narrow wafers, rough wafers and possibly greater wafer thickness variation.

Species segregation is not a very desirable alternative because of the high cost of retrofitting plants for segregated processing. Furthermore, there are additional costs associated with handling and management at the mill yard and in the forest.

The higher moisture content and lower density of balsam poplar would also increase the delivery cost of logs per tonne of dry fibre. Average hauling distance could be reduced but this would be relatively minor in relation to the additional labour costs.

Plant retrofit for segregated processing would require the addition of a second line with expanded log thawing capacity and the addition of a debarker, flaker, storage bind (possibly) and dryer. The total cost could be in excess of $5,000,000.

Some waferboard mills will tolerate up to 5 percent balsam poplar on an uncontrolled basis. Larger amounts would require longer press times and/or an increase in resin content at costs that are too high in terms of a practical alternative. One mill (B.C.) is reported to be using significant amounts of balsam poplar without segregation; however, the means by which this is accomplished and the consequences (if any) may not be appropriate or acceptable to the industry in general.

5.0 SUMMARY AND ACTION STATEMENT

There is no doubt that balsam poplar has inherent characteristics that seriously restrict its use in mixture with the traditional aspen furnish used by this industry.

On the basis of the two meetings held to date, the Task Force members established the groundwork for the research and testing required to facilitate the use of black poplar in waferboard/OSB production.

5.1 Laboratory R &D

The Task Force recommends work to:

- characterize regional and seasonal property variations in balsam poplar (pH, density, moisture content)
- examine resin formulations and types suited to the characteristics of balsam poplar wafers
- establish optimum conditions for waferizing (knife profiles, log MC and log temperature)
- examine drying characteristics of mixed species and procedures for uniform MC

5.2 Laboratory - Mill Cooperative Studies

The Task Force recommends work to:

- assess log MC control via harvesting and storage techniques and relate to waferizing/drying performance (balsam poplar and mixed aspen/balsam poplar)

5.3 Mill Trials

The Task Force's recommendations for an initial mill trial are based on completion of laboratory investigations of log MC control and optimum waferizing parameters. The recommendations are:

- to lay out test logs for appropriate storage/drying periods
- to set waferizer knives for optimum cut
- to run a 100% balsam poplar sample for 1/4 inch boards for initial feedback
- to follow-up with additional trials on structural board, step by step, based on initial findings
- to obtain cost data for modified handling or processing procedures

5.4 Cooperating and Supporting Organizations

. Forintek Canada Corp. (coordinator)
. Alberta Research Council
. Universities (U of T coordination on regional aspects)
. Government of Alberta
. Industry - Grant Waferboard
- Pelican Mills
- Weldwood of Canada

6.0 ACKNOWLEDGEMENT

The Author wishes to acknowledge the valuable input from the Task Force, industry, Universities and research organizations.

Figure 1

Growth Range of Balsam Poplar

APPENDIX I

Comparative Tables on Balsam Poplar and Aspen Waferboard/OSB Properties

Table 1. Comparison of Aspen and Black Poplar Waferboard/OSB Test Results - Modulus of Rupture

PANEL TYPE / Source	PROCESS PARAMETERS: Panels (#) Th.	Dens. (pcf)	Resin (Type/%)	Wax (%)	Press (min./°F)	Mat M.C. (%)	Flake Th. (0.001'')	MODULUS OF RUPTURE (psi): CAN-0437.0 min.: (R-1: 2500) (O-2: 4200/1800) Aspen 100%	Mixture (%)	Mixture •	Mixture (%)	B. Poplar 100%
RANDOM												
ARC: FPLE-99	(5) 7/16	41-42	(PPF/2.5)	1.2	(4.3/400)	5	27	5555		-		4815
	.....	.....	(PPF/1.5)	.....	.....	.....	.....	4670		-		4626
Panning and Gertjejansen	(3) 1/2	36	(PPF/3.0)	1.0	(8.0/450)	3	31	2930		-		3290
Morrison-Knudsen Maxi-chip rf.ARC								(1)				
Face Flakes	(10) 7/16	43	(LPF/5.0)	1.0	(5.0/405)	7	17	5300		-		4750
Core Flakes	(10)	42-40	.....	.....	.....	.....	.....	3350		-		2850
Thesis (Badger,S)	(3) 1/2	40	(PPF/2.7)	f. 1.7	(5.5/410)	7	26	2392	(73)	2163	(27)	-
*Mill-run			3.1	c. 1.5								
							A/BP					
ARC: FPLI-48	(5) 7/16	40-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30	3923	(50)	3910	(50)	3910
Hsu, E.	(6) 7/16	41	(PPF/3.0)	1.0	(5.0/410)	5	30	4153	(85)	4448	(15)	4802
									(50)	4500	(50)	
							A/BP					
Reichhold	(3) 7/16	41-40	(PPF/2.4)	1.5	(5.0/400)	6/4	26/18	(2) 3793	(80)	3566	(20)	3502
									(60)	3474	(40)	
Bordan	(?) 7/16	41-40	(LPF/2.4)	1.5	(3.5/410)	3	25/16	4430	(80)	3495	(20)	3060
									(60)	2759	(40)	
ORIENTED												
ARC: FPLI-48	(5) 7/16	38-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30					
Para.	.....	.....	.....	.....	.....	.....	.....	4656	(50)	5038	(50)	4830
Perp.	.....	.....	.....	.....	.....	.....	.....	3365	(50)	3408	(50)	3292
Morrison-Knudsen Maxi-chip												
3-layer 50:50	(1) 7/16	38	(LPF/5.0)	1.0	(6.0/400)	9-10						
Para.	.....	.....	.....	.....	.....	.....	.....	5540	(70)	6380	(30)	-
Perp.	.....	.....	.....	.....	.....	.....	.....	2670	(70)	2780	(30)	-
Single-Layer	(5) 7/16	41	(LPF/5.0)	1.0	(6.0/400)	8-10	A/BP					
Face flakes												
Para.	.....	.....	.....	.....	.....	.....	17/18	-		-		-
Perp.	.....	.....	.....	.....	.....	.....	.....	-		-		-
Core flakes												
Para.	.....	.....	.....	.....	.....	.....	18/14	-		-		-
Perp.	.....	.....	.....	.....	.....	.....	.....	-		-		-

1) Average of two panel directions

2) Average of small and large wafers

APPENDIX I

Table 2. Comparison of Aspen and Black Poplar Waferboard/OSB Test Results - Modulus of Elasticity

PANEL TYPE / Source	PROCESS PARAMETERS: Panels (#) Th.	Dens. (pcf)	Resin (Type/%)	Max (%)	Press (min./°F)	Mat M.C. (%)	Flake Th. (0.001")	MODULUS OF ELASTICITY (Psi x 10^3) CAN-0437 min.: (R-1:450) (O-2:800/225) Aspen 100%	Mixture (%) • (%)	B. Poplar 100%
RANDOM										
ARC: FPLE-99	(5) 7/16	41-42	(PPF/2.5)	1.2	(4.3/400)	5	27	812	–	725
	.....		(PPF/1.5)					768	–	725
Panning and Gartjejansen	(3) 1/2	36	(PPF/3.0)	1.0	(8.0/450)	3	31	612	–	625
Morrison-Knudsen Maxi-chip rf.ARC										
Face Flakes	(10) 7/16	43	(LPF/5.0)	1.0	(5.0/405)	7	17	(1) 790	–	681
Core Flakes	(10)	42-40	.....					544	–	457
Thesis (Badger,S) *Mill-run	(3) 1/2	40	(PPF/2.7) 3.1	f. 1.7 c. 1.5	(5.5/410)	7	26	–	–	–
ARC: FPLI-48	(5) 7/16	40-42	(PPF/2.0)	1.0	(5.0/400)	5	A/BP 25/30	594	(50) 588 (50)	594
Hsu, E.	(6) 7/16	41	(PPF/3.0)	1.0	(5.0/410)	5	30	624	(85) 642 (15)	674
Reichhold	(3) 7/16	41-40	(PPF/2.4)	1.5	(5.0/400)	6/4	A/BP 26/18		(50) 680 (50)	
Borden	(7) 7/16	41-40	(LPF/2.4)	1.5	(3.5/410)	3	25/16	(2) 548	(80) 582 (20) (60) 555 (40)	558
ORIENTED								–	–	–
ARC: FPLI-48	(5) 7/16	38-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30			
Para.	.....							870	(50) 943 (50)	899
Perp.	.....							464	(50) 421 (50)	406
Morrison-Knudsen Maxi-chip										
3-layer 50:50	(1) 7/16	38	(LPF/5.0)	1.0	(6.0/400)	9-10				
Para.	.....							1129	(70) 1181 (30)	–
Perp.	.....							336	(70) 336 (30)	–
Single-Layer										
Face flakes	(5) 7/16	41	(LPF/5.0)	1.0	(6.0/400)	8-10	A/BP			
Para.	.....							1536	–	1406
Perp.	.....						17/18	278	–	229
Core flakes										
Para.	.....							1167	–	1013
Perp.	.....						18/14	210	–	196

1) Average of two panel directions
2) Average of small and large wafers

Table 3. Comparison of Aspen and Black Poplar Waferboard/OSB Test Results - Internal Bond

PANEL TYPE / Source	PROCESS PARAMETERS: Panels (#) Th.	Dens. (pcf)	Resin (Type/%)	Wax (%)	Press (min./°F)	Mat M.C. (%)	Flake Th. (0.001")	INTERNAL BOND (psi): CAN-0437.0 min.:50 Aspen 100%	Mixture (%)	Mixture *	Mixture (%)	B. Poplar 100%
RANDOM												
ARC: FPLE-99	(5) 7/16	41-42	(PPF/2.5)	1.2	(4.3/400)	5	27	104		-		67
	.....		(PPF/1.5)	.....	.....	.....	.....	82		-		68
Panning and Gartjejansen	(3) 1/2	36	(PPF/3.0)	1.0	(8.0/450)	3	31	73		-		69
Morrison-Knudsen Maxi-chip rf.ARC												
Face Flakes	(10) 7/16	43	(LPF/5.0)	1.0	(5.0/405)	7	17	116		-		95
Core Flakes	(10)	42-40	.....	.....	.....	.....	.....	120		-		102
Thesis (Badger,S) *Mill-run	(3) 1/2	40	(PPF/2.7) 3.1	f. 1.7 c. 1.5	(5.5/410)	7	26	55	(73)	48	(27)	-
ARC: FPLI-48	(5) 7/16	40-42	(PPF/2.0)	1.0	(5.0/400)	5	A/BP 25/30	63	(50)	54	(50)	55
Hsu, E.	(6) 7/16	41	(PPF/3.0)	1.0	(5.0/410)	5	30	102	(85)	94	(15)	82
									(50)	83	(50)	
Reichhold	(3) 7/16	41-40	(PPF/2.4)	1.5	(5.0/400)	6/4	A/BP 26/18	80	(80)	61	(20)	33
									(60)	52	(40)	
Bordan	(?) 7/16	41-40	(LPF/2.4)	1.5	(3.5/410)	3	25/16	78	(80)	52	(20)	30
									(60)	35	(40)	
ORIENTED												
ARC: FPLI-48	(5) 7/16	38-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30	54	(50)	78	(50)	66
Para.	.....											
Perp.	.....											
Morrison-Knudsen Maxi-chip												
3-layer 50:50	(1) 7/16	38	(LPF/5.0)	1.0	(6.0/400)	9-10		76	(70)	60	(30)	-
Para.	.....											
Perp.	.....											
Single-Layer Face flakes	(5) 7/16	41	(LPF/5.0)	1.0	(6.0/400)	8-10	A/BP					
Para.	.....						17/18	-		-		-
Perp.	.....							-		-		-
Core flakes												
Para.	.....						18/14	-		-		-
Perp.	.....							-		-		-

Table 4. Comparison of Aspen and Black Poplar Waferboard/OSB Test Results - Bond Durability

PANEL TYPE / Source	PROCESS PARAMETERS: Panels (#) Th.	Dens. (pcf)	Resin (Type/%)	Wax (%)	Press (min./°F)	Mat M.C. (%)	Flake Th. (0.001")	BOND DURABILITY - RETENTION OF M.O.R. (%): CAN-3437.0 min.:50% of Dry MOR min. Aspen 100%	Mixture (%)	*	(%)	B. Poplar 100%
RANDOM												
ARC: FPLE-99	(5) 7/16	41-42	(PPF/2.5)	1.2	(4.3/400)	5	27	51		-		54
	.....		(PPF/1.5)	.....	.....	.....	.....	55		-		57
Panning and Gertjejansen	(3) 1/2	36	(PPF/3.0)	1.0	(8.0/450)	3	31	55		-		57
Morrison-Knudsen Maxi-chip rf.ARC												
Face Flakes	(10) 7/16	43	(LPF/5.0)	1.0	(5.0/405)	7	17	56		-		54
Core Flakes	(10)	42-40	.....	.....	.....	.....	.....	53		-		55
Thesis (Badger,S)	(3) 1/2	40	(PPF/2.7)	f. 1.7	(5.5/410)	7	26	62	(73)	51	(27)	-
*Mill-run			3.1	c. 1.5			A/BP					
ARC: FPLI-48	(5) 7/16	40-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30	55	(50)	57	(50)	54
Hsu, E.	(6) 7/16	41	(PPF/3.0)	1.0	(5.0/410)	5	30	53	(85)	52	(15)	52
									(50)	53	(50)	
							A/BP					
Reichhold	(3) 7/16	41-40	(PPF/2.4)	1.5	(5.0/400)	6/4	26/18	49	(80)	47	(20)	54
									(60)	52	(40)	
Borden	(7) 7/16	41-40	(LPF/2.4)	1.5	(3.5/410)	3	25/16	48	(80)	46	(20)	41
									(60)	42	(40)	
ORIENTED												
ARC: FPLI-48	(5) 7/16	38-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30					
Para.	.....							50	(50)	53	(50)	50
Perp.	.....							53	(50)	54	(50)	52
Morrison-Knudsen Maxi-chip												
3-layer 50:50	(1) 7/16	38	(LPF/5.0)	1.0	(6.0/400)	9-10						
Para.	.....							-		-		-
Perp.	.....							-		-		-
Single-Layer	(5) 7/16	41	(LPF/5.0)	1.0	(6.0/400)	8-10	A/BP					
Face flakes												
Para.	.....						17/18	-		-		-
Perp.	.....							-		-		-
Core flakes												
Para.	.....						18/14	-		-		-
Perp.	.....							-		-		-

Table 5. Comparison of Aspen and Black Poplar Waferboard/OSB Test Results - Thickness Swell

PANEL TYPE / Source	PROCESS PARAMETERS: Panels (#) Th.	Dens. (pcf)	Resin (Type/%)	Wax (%)	Press (min./°F)	Mat M.C. (%)	Flake Th. (0.001")	THICKNESS SWELL (%): CAN-0437.0 max.: 25% Aspen 100%		Mixture *	(%)	B. Poplar 100%
RANDOM												
ARC: FPLE-99	(5) 7/16	41-42	(PPF/2.5)	1.2	(4.3/400)	5	27	19		-		21
	.....		(PPF/1.5)	.....				21		-		29
Panning and Gertjejansen	(3) 1/2	36	(PPF/3.0)	1.0	(8.0/450)	3	31	* 24		-		32
Morrison-Knudsen Maxi-chip rf.ARC												
Face Flakes	(10) 7/16	43	(LPF/5.0)	1.0	(5.0/405)	7	17	-		-		-
Core Flakes	(10)	42-40	.....					-		-		-
Thesis (Badger,S) *Mill-run	(3) 1/2	40	(PPF/2.7) 3.1	f. 1.7 c. 1.5	(5.5/410)	7	26	18	(73)	19	(27)	-
ARC: FPLI-48	(5) 7/16	40-42	(PPF/2.0)	1.0	(5.0/400)	5	A/BP 25/30	32	(50)	34	(50)	34
Hsu, E.	(6) 7/16	41	(PPF/3.0)	1.0	(5.0/410)	5	30	** 13	(85)	16	(15)	16
									(50)	16	(50)	
Reichhold	(3) 7/16	41-40	(PPF/2.4)	1.5	(5.0/400)	6/4	A/BP 26/18	14	(80)	16	(20)	18
									(60)	11	(40)	
Borden	(?) 7/16	41-40	(LPF/2.4)	1.5	(3.5/410)	3	25/16	-		-		-
								-		-		-
ORIENTED												
ARC: FPLI-48	(5) 7/16	38-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30	20	(50)	29	(50)	30
Para.	.....							-		-		-
Perp.	.....											
Morrison-Knudsen Maxi-chip												
3-layer 50:50	(1) 7/16	38	(LPF/5.0)	1.0	(6.0/400)	9-10		-		-		-
Para.	.....							-		-		-
Perp.	.....											
Single-Layer	(5) 7/16	41	(LPF/5.0)	1.0	(6.0/400)	8-10	A/BP					
Face flakes												
Para.	.....						17/18	-		-		-
Perp.	.....							-		-		-
Core flakes												
Para.	.....						18/14	-		-		-
Perp.	.....							-		-		-

* 50% RH/2h. Boil

** 65% RH/24h. Soak

Table 6. Comparison of Aspen and Black Poplar Waferboard/OSB Test Results - Linear Expansion

PANEL TYPE / Source	PROCESS PARAMETERS: Panels (#) Th.	Dens. (pcf)	Resin (Type/%)	Wax (%)	Press (min./°F)	Mat M.C. (%)	Flake Th. (0.001'')	LINEAR EXPANSION (%): CAN-0437.0 max. (OD/S:0.40) (50/90 RH:0.20) Aspen 100%	Mixture (%)	*	(%)	B. Poplar 100%
RANDOM												
ARC: FPLE-99	(5) 7/16	41-42	(PPF/2.5)	1.2	(4.3/400)	5	27	0.21		-		0.22
	.....		(PPF/1.5)	.....	.....	.....	.....	0.23		-		0.23
Panning and Gertjejansen	(3) 1/2	36	(PPF/3.0)	1.0	(8.0/450)	3	31	* 0.034		-		0.043
Morrison-Knudsen Maxi-chip rf.ARC												
Face Flakes	(10) 7/16	43	(LPF/5.0)	1.0	(5.0/405)	7	17	0.19		-		0.18
Core Flakes	(10)	42-40	.....	.....	.....	.....	.....	0.29		-		0.28
Thesis (Badger,S) *Mill-run	(3) 1/2	40	(PPF/2.7) 3.1	f. 1.7 c. 1.5	(5.5/410)	7	26	0.60	(73)	0.48	(27)	-
							A/BP					
ARC: FPLI-48	(5) 7/16	40-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30	0.28	(50)	0.30	(50)	0.26
Hsu, E.	(6) 7/16	41	(PPF/3.0)	1.0	(5.0/410)	5	30	** 0.018	(85)	0.018	(15)	0.019
									(50)	0.017	(50)	
							A/BP					
Reichhold	(3) 7/16	41-40	(PPF/2.4)	1.5	(5.0/400)	6/4	26/18	0.14	(80)	0.16	(20)	0.16
									(60)	0.16	(40)	
Borden	(?) 7/16	41-40	(LPF/2.4)	1.5	(3.5/410)	3	25/16	-		-		-
								-		-		-
ORIENTED												
ARC: FPLI-48	(5) 7/16	38-42	(PPF/2.0)	1.0	(5.0/400)	5	25/30					
Para.	.....							0.27	(50)	0.22	(50)	0.26
Perp.	.....							0.28	(50)	0.26	(50)	0.31
Morrison-Knudsen Maxi-chip												
3-layer 50:50	(1) 7/16	38	(LPF/5.0)	1.0	(6.0/400)	9-10						
Para.	.....							0.15	(70)	0.19	(30)	-
Perp.	.....							0.39	(70)	0.22	(30)	-
Single-Layer	(5) 7/16	41	(LPF/5.0)	1.0	(6.0/400)	8-10	A/BP					
Face flakes												
Para.	.....						17/18	0.10		-		0.07
Perp.	.....							0.64		-		0.64
Core flakes												
Para.	.....						18/14	0.07		-		0.15
Perp.	.....							1.02		-		0.80

* 50% RH/2h. Boil

** 65% RH/24h. Soak

APPENDIX II

Literature Compiled for Task Force on
Black (Balsam) Poplar for Waferboard/OSB

APPENDIX II

LITERATURE COMPILED FOR TASK FORCE ON BLACK (BALSAM) POPLAR FOR WAFERBOARD/OSB

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